

The University of Bradford Institutional Repository

<http://bradscholars.brad.ac.uk>

This work is made available online in accordance with publisher policies. Please refer to the repository record for this item and our Policy Document available from the repository home page for further information.

To see the final version of this work please visit the publisher's website. Available access to the published online version may require a subscription.

Link to original published version: <http://dx.doi.org/10.1093/ageing/afw039>

Citation: Clegg A, Bates C, Young J, Ryan R, Nichols L, Teale EA, Mohammed MA, Parry J and Marshall T (2016) Development and validation of an electronic frailty index using routine primary care electronic health record data. *Age and ageing*. Online before print, 3rd March 2016.

Copyright statement: © 2016 The Authors. Published open access by Oxford Journals. Reproduced in accordance with the publisher's self-archiving policy.



Deficit	Development cohort n=207,814	Internal validation cohort n=207,720	External validation cohort n=516,007
Activity limitation	2,282 (1.1%)	2275 (1.1%)	7,722 (1.5%)
Anaemia & haematinic deficiency	48,252 (23.2%)	48967 (23.6%)	95,564 (18.5%)
Arthritis	67,802 (32.6%)	68073 (32.8%)	177,862 (34.5%)
Atrial fibrillation	18,218 (8.8%)	18268 (8.8%)	42,306 (8.2%)
Cerebrovascular disease	19,263 (9.3%)	19039 (9.2%)	50,646 (9.8%)
Chronic kidney disease	43,184 (20.8%)	43214 (20.8%)	151,234 (29.3%)
Diabetes	29,595 (14.2%)	29389 (14.1%)	70,329 (13.6%)
Dizziness	30,875 (14.9%)	31099 (15.0%)	124,536 (24.1%)
Dyspnoea	30,831 (14.8%)	31164 (15.0%)	101,645 (19.7%)
Falls	21,149 (10.1%)	21043 (10.1%)	71,666 (13.9%)
Foot problems	5,273 (2.5%)	5237 (2.5%)	19,845 (3.9%)
Fragility fracture	16,972 (8.2%)	16943 (8.2%)	44,191 (8.6%)
Hearing impairment	33,435 (16.1%)	33246 (16.0%)	94,155 (18.3%)
Heart failure	10,196 (4.9%)	10287 (5.0%)	24,064 (4.7%)
Heart valve disease	1,662 (0.8%)	1690 (0.8%)	8,416 (1.6%)
Housebound	28,470 (13.7%)	28571 (13.8%)	116,458 (22.6%)
Hypertension	104,468 (50.3%)	104818 (50.5%)	262,005 (50.8%)
Hypotension/syncope	16,561 (8.0%)	16508 (7.9%)	58,034 (11.3%)
Ischaemic heart disease	37,971 (18.3%)	37902 (18.2%)	162,650 (31.5%)
Memory & cognitive problems	9,781 (4.7%)	9675 (4.7%)	29,799 (5.8%)
Mobility & transfer problems	12,140 (5.8%)	12216 (5.9%)	6,709 (1.3%)
Osteoporosis	16,876 (8.1%)	16971 (8.2%)	46,374 (9.0%)
Parkinsonism & tremor	2,660 (1.3%)	2780 (1.3%)	9,866 (1.9%)
Peptic ulcer	10,291 (5.3%)	10915 (5.3%)	33,902 (6.6%)
Peripheral vascular disease	8,932 (4.3%)	8899 (4.3%)	12,861 (2.5%)
Polypharmacy	143,487 (69.0%)	143968 (69.3%)	361,804 (70.1%)
Requirement for care	12,495 (6.0%)	12087 (5.8%)	5,809 (1.1%)
Respiratory disease	51,557 (24.8%)	51445 (24.8%)	129,432 (25.1%)
Skin ulcer	9,240 (4.4%)	9185 (4.4%)	47,203 (9.2%)
Sleep disturbance	14,290 (6.9%)	14309 (6.9%)	46,221 (9.0%)
Social vulnerability	15,444 (7.4%)	15463 (7.4%)	19,695 (3.8%)
Thyroid disease	29,519 (14.2%)	29598 (14.2%)	74,570 (14.5%)

Urinary incontinence	11,279 (5.4%)	11276 (5.4%)	33,522 (6.5%)
Urinary system disease	60,668 (29.1%)	60858 (29.3%)	174,848 (33.9%)
Visual impairment	55,640 (26.8%)	55914 (26.9%)	115,001 (22.3%)
Weight loss & anorexia	7,296 (3.5%)	7265 (3.5%)	25,799 (5.0%)

Web table 1. Prevalence of individual deficits in the development, internal validation and external validation cohorts.

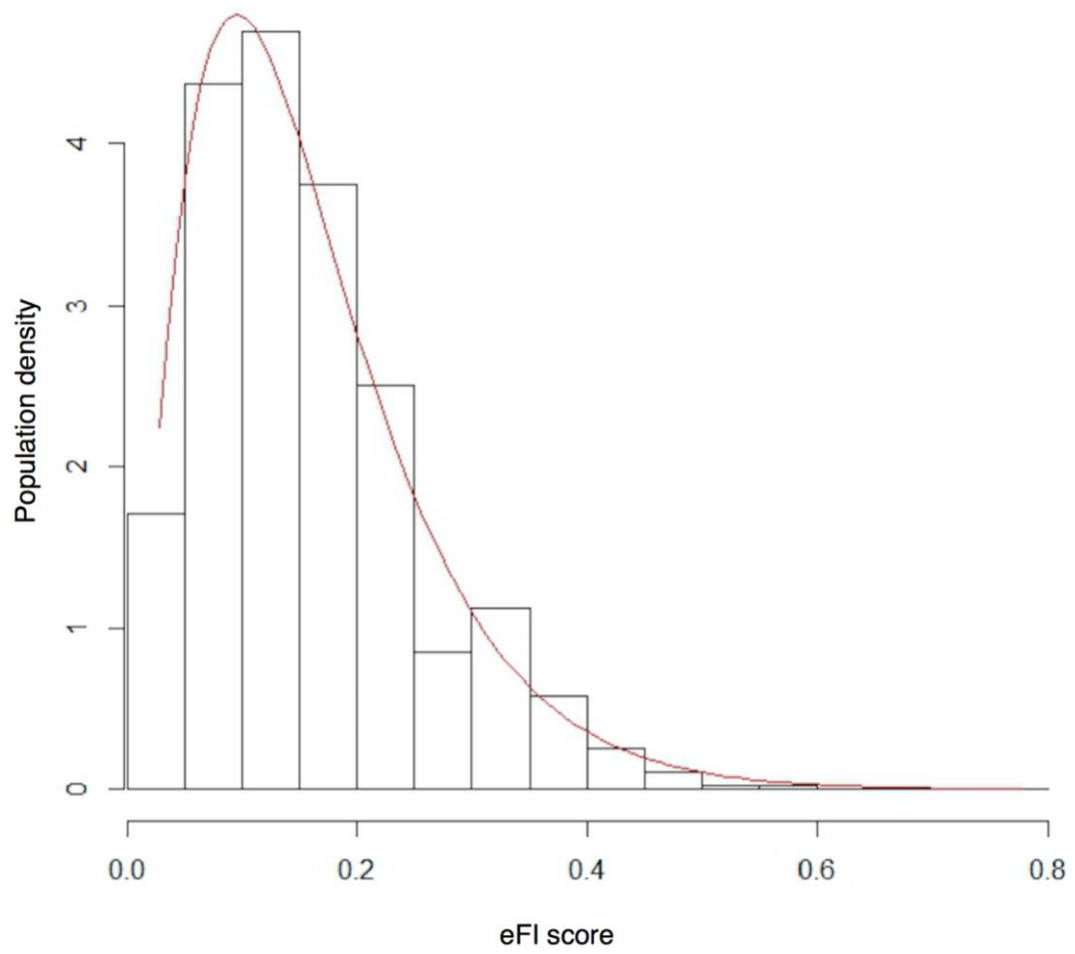
Outcome	Internal validation				External validation			
	Fit	Mild frailty	Moderate frailty	Severe frailty	Fit	Mild frailty	Moderate frailty	Severe frailty
1 year mortality	1,721 1.7%	3,263 4.7%	2,413 10.6%	971 19.1%	3,011 1.4%	6,460 3.4%	5,477 6.9%	2,623 11.7%
3 year mortality	5,693 5.7%	9,633 14.0%	6,530 28.6%	2,418 47.5%	9,652 4.3%	18,632 9.8%	14,476 18.2%	6,544 29.2%
5 year mortality	10,263 10.2%	16,271 23.6%	10,160 44.5%	3,540 69.5%	17,132 7.7%	30,698 16.1%	22,224 27.9%	9,408 42.0%
1 year emergency hospitalisation	4,406 4.4%	6,278 9.1%	3,519 15.4%	1,276 25.1%	5,415 5.9%	10,304 13.2%	8,000 24.1%	3,588 37.2%
3 year emergency hospitalisation	13,483 13.4%	16,839 24.3%	8,198 35.9%	2,451 48.1%	14,545 15.8%	24,333 31.2%	15,980 48.1%	6,169 63.9%
5 year emergency hospitalisation	24,161 24.0%	27,163 39.3%	12,051 52.8%	3,151 61.9%				
1 year nursing home admission	270 0.3%	570 0.8%	464 2.0%	195 3.8%				
3 year nursing home admission	1,151 1.1%	2,087 3.0%	1,476 6.5%	525 10.3%				
5 year nursing home admission	2,692 2.7%	4,355 6.3%	2,647 11.6%	842 16.5%				

Web table 2. Absolute numbers and percentages of older people characterised as fit, mild frailty, moderate frailty and severe frailty experiencing outcomes of mortality, emergency hospitalisation and nursing home admission in the internal validation and external validation cohorts.

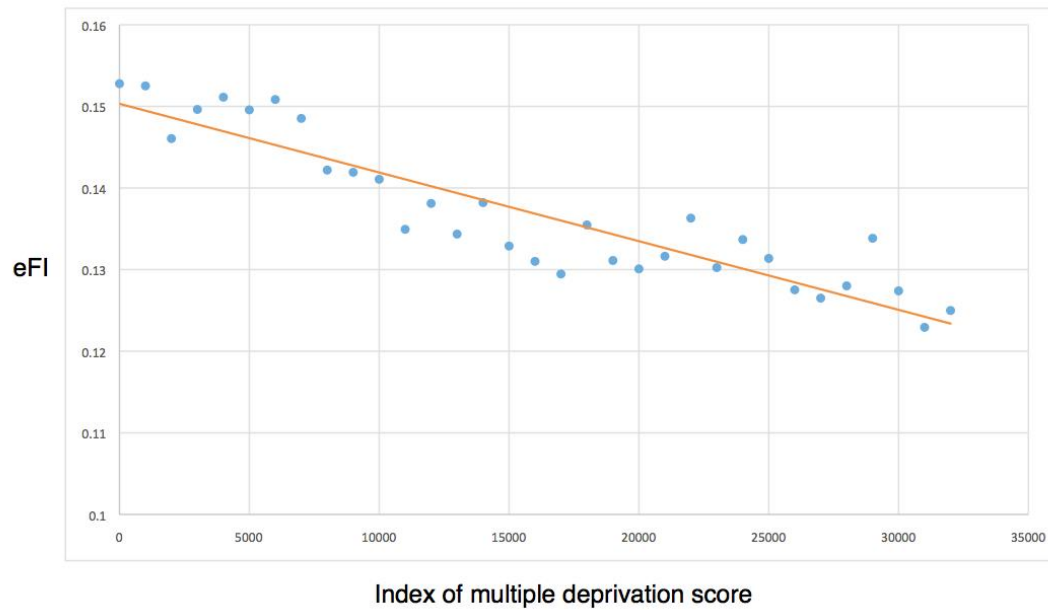
	Fit	Mild frailty	Moderate frailty	Severe frailty
Number of patients	92,217	77,946	33,251	9,650
Admission rate per 1,000 pyr (95% CI)				
All admissions	336.1 (334.0 to 338.2)	643.2 (640.0 to 646.4)	1013.7 (1007.3 to 1020.1)	1550.7 (1535.1 to 1566.4)
Emergency admissions	90.1 (89.0 to 91.1)	211.3 (209.5 to 213.1)	407.3 (403.3 to 411.4)	706.7 (696.1 to 717.3)
Bed-days per admission				
All admissions				
Number of patients	36,159	46,053	23,440	7,514
Mean (SD)	3.8 (12.5)	4.7 (13.0)	5.7 (14.3)	6.7 (16.0)
Median (IQR)	0.5 (0.5 to 2.0)	0.5 (0.5 to 3.0)	0.5 (0.5 to 5.0)	0.5 (0.5 to 7.0)
Emergency admissions				
Number of patients	16,380	26,828	17,180	6,470
Mean (SD)	9.0 (19.1)	9.6 (17.4)	10.3 (16.5)	11.1 (18.5)
Median (IQR)	4.0 (1.0 to 10.0)	4.0 (1.0 to 11.0)	5.0 (1.0 to 12.0)	5.0 (1.0 to 13.0)

Web table 3. Admission rates per 1,000 person years and bed days per admission for people defined as fit, mild frailty, moderate frailty and severe frailty.

Key: CI, confidence interval; pyr, person years; SD, standard deviation; IQR, interquartile range



Web figure 1. Population distribution of the electronic frailty index (internal validation cohort).



Web figure 2. Relationship between eFI and social deprivation, measured using the Index of Multiple Deprivation (IMD). The IMD ranks every neighbourhood in England from 1 (most deprived) to 32,844 (least deprived). Data presented are from internal validation cohort.